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# LB1940T

**ON Semiconductor®**

http://onsemi.com

**Monolithic Digital IC**

# 2-ch H-Bridge Constant Current Driver

## Overview

The LB1940T is 2-phase exciter type bipolar stepper motor driver ICs that feature low-voltage, (supporting 3V battery) and low current operation with low saturation voltage. This IC enable constant-current control of actuators, and are optimal for driving the actuators of PC peripherals such as USB compatible scanners, FDDs, and printers, as well as for controlling the shutter, iris, and AF of a digital still camera.

## Features

- Low-voltage driving
  2-power source type:        $VS = 1.6$ to $7.5V$, $V_{DD} = 1.9$ to $6.5V$
  Single power source type:  $VS = V_{DD} = 1.9$ to $7.5V$
- Low saturation output:     $V_O(sat) = 0.3V$ at $I_O$ of 200mA
- Constant-current control
- Built-in reference voltage (Vref = 0.9V)
- Small-sized, low-profile package (TSSOP20; 225mil; thickness (t) = 1.2mm max.)

## Specifications

### Absolute Maximum Ratings at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Maximum supply voltage | VB max | VS1, VS2, $V_{DD}$ | -0.3 to +10.5 | V |
| Output applied voltage | $V_{OUT}$ max | OUT1, OUT2, OUT3, OUT4 | -0.3 to +10.5 | V |
| Output Current | $I_O$ max | | 400 | mA |
| Input applied voltage | $V_{IN}$ max | ENA1, ENA2, IN1, IN2, VC | -0.3 to +10.5 | V |
| Allowable power dissipation | Pd max | Mounted on a specified board * | 800 | mW |
| Operating temperature | Topr | | -20 to +85 | °C |
| Storage temperature | Tstg | | -55 to +150 | °C |

* Mounted on a Specified board: 114.3mm×76.1mm×1.6mm, glass epoxy

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

## ORDERING INFORMATION

See detailed ordering and shipping information on page 8 of this data sheet.

# LB1940T

## Allowable Operating Range at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings min | Ratings typ | Ratings max | unit |
|---|---|---|---|---|---|---|
| Function-guaranteed voltage range | VOPR1 | $V_{DD}$ system, VS = 2.0V | 1.9 | | 6.5 | V |
| | VOPR2 | VS system, $V_{DD}$ = 5.0V | 1.6 | | 7.5 | V |
| Low level input threshold voltage | $V_{IL}$ | ENA1, ENA2, IN1, IN2 | -0.3 | | 1.0 | V |
| High level input threshold voltage | $V_{IH}$ | ENA1, ENA2, IN1, IN2 | 2.0 | | 6.0 | V |
| VC input voltage | VC | | 0.19 | | 1.0 | V |

## Electrical Characteristics at Ta = 25°C, VS = 3V, $V_{DD}$ = 5V

| Parameter | Symbol | Conditions | Ratings min | Ratings typ | Ratings max | unit |
|---|---|---|---|---|---|---|
| Standby current dissipation | ISTB | VS = $V_{DD}$ = 6.5V | | 0.1 | 1.0 | μA |
| **Regulator output circuit** | | | | | | |
| VREF output voltage | VREF | $I_{OL}$ = 0 to 1mA | 0.85 | 0.9 | 0.95 | V |
| SVDD output voltage | VSVDD | $I_{OL}$ = 10mA | 4.70 | 4.85 | | V |
| **H bridge output circuit** | | | | | | |
| OUT output saturation voltage (at saturation control) | $V_O(sat)1$ | $V_{DD}$ = 5.0V, VS = 2.0V $I_O$ = 200mA (PNP side) | | 0.20 | 0.30 | V |
| | $V_O(sat)2$ | $V_{DD}$ = 5.0V, VS = 2.0V $I_O$ = 200mA (NPN side) | | 0.10 | 0.15 | V |
| OUT output current (at constant current control) | $I_{OUT}1$ | $V_{DD}$ = 6.0V, VC = 0.2V, VS = 3.5V $R_L$ = 5Ω (between OUT-OUT), RFB = 2Ω | 94 | 100 | 106 | mA |
| | $I_{OUT}2$ | $VC = \dfrac{Rb}{Ra + Rb}$ VREF (Ra = 70kΩ, Rb = 20kΩ) * $V_{DD}$ = 6.0V, VS = 2.0V $R_L$ = 5Ω (between OUT-OUT), RFB = 1Ω | 180 | 200 | 220 | mA |
| VS system operating current consumption | IS1 | $VC = \dfrac{Rb}{Ra + Rb}$ VREF (Ra = 70kΩ, Rb = 20kΩ) * | | 1.5 | 3 | mA |
| $V_{DD}$ system operating current dissipation | $I_{DD}1$ | $VC = \dfrac{Rb}{Ra + Rb}$ VREF (Ra = 70kΩ, Rb = 20kΩ) * ENA1 = 2V | | 4 | 7 | mA |
| VC input current | IVC | $V_{DD}$ = 6.0V, VS = 2.0V, VC = 1.9V | 0 | | -1 | μA |
| **Control input circuit** | | | | | | |
| Control pin maximum input current | $I_{IH}$ | $V_{IH}$ = 5.5V | | 80 | 100 | μA |
| | $I_{IL}$ | $V_{IL}$ = GND | -1 | | 0 | |

* For Ra and Rb, refer to Application Circuit Diagram.

## Package Dimensions

unit : mm (typ)



TSSOP20(225mil)



Pd max - Ta

Mounted on a Specified board:
114.3mm×76.1mm×1.6mm glass epoxy

800mW

Allowable Power Dissipation, Pd max - mW

Ambient Temperature, Ta- °C          ILB01486
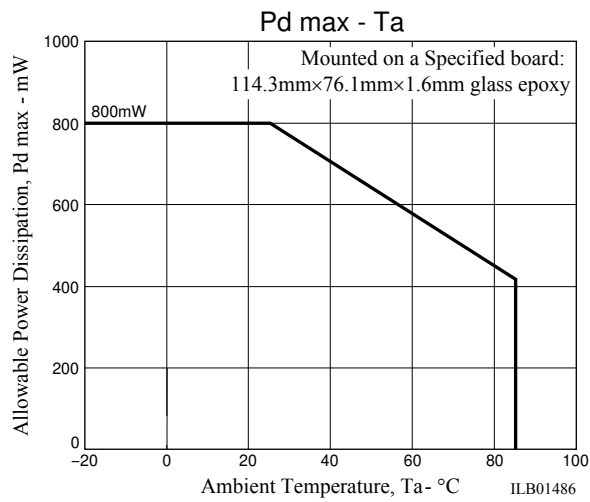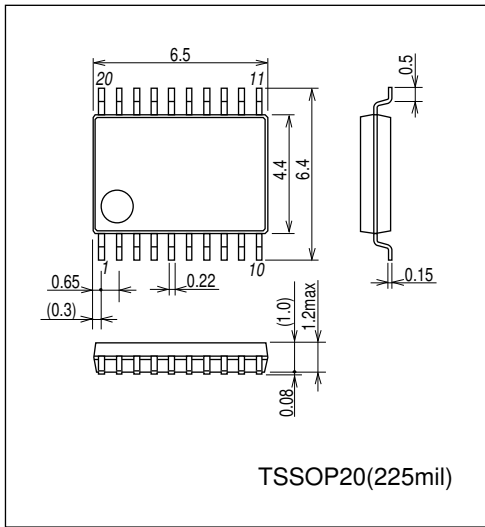
## True Table

| Input | | | | Output | | | | | | Mode |
|---|---|---|---|---|---|---|---|---|---|---|
| ENA | | IN | | OUT | | | | SVDD | | |
| 1 | 2 | 1 | 2 | 1 | 2 | 3 | 4 | | | |
| L | L | | | | | | | | | Standby (current dissipation zero) |
| H | | H | | L | H | | | on | | Reverse rotation |
| | | L | | H | L | | | on | | Forward rotation |
| | H | | H | | | L | H | on | | Reverse rotation |
| | | | L | | | H | L | on | | Forward rotation |
| A blank means "don't care". | | | | A blank means "off". | | | | | | |

## Pin Assignment



Top view
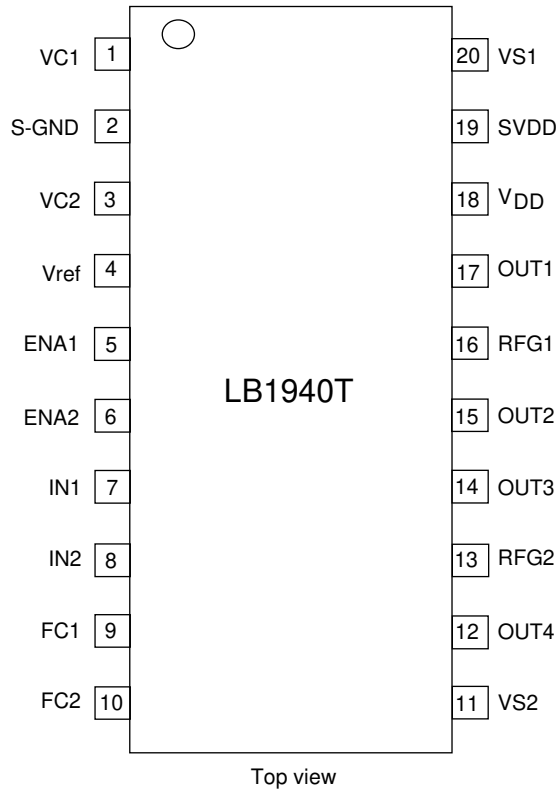
## Pin Description

| Pin No. LB1940T | Pin Name | Description | Pin No. LB1940T | Pin Name | Description |
|---|---|---|---|---|---|
| 1 | VC1 | Reference voltage input for 1ch control | 11 | VS2 | Motor power supply (+) |
| 2 | S-GND | GND for control system | 12 | OUT4 | Motor drive output 4 |
| 3 | VC2 | Reference voltage input for 2ch control | 13 | RFG2 | Constant-current detection pin |
| 4 | Vref | Reference voltage output | 14 | OUT3 | Motor drive output 3 |
| 5 | ENA1 | Signal input for 1ch control | 15 | OUT2 | Motor drive output 2 |
| 6 | ENA2 | Signal input for 2ch control | 16 | RFG1 | Constant-current detection pin 1 |
| 7 | IN1 | Signal input for 1ch control | 17 | OUT1 | Motor drive output 1 |
| 8 | IN2 | Signal input for 2ch control | 18 | $V_{DD}$ | Control system power supply (+) |
| 9 | FC1 | C connection pin for 1ch phase compensation | 19 | SVDD | Control system power output |
| 10 | FC2 | C connection pin for 2ch phase compensation | 20 | VS1 | Motor power supply (+) |

## Block Diagram
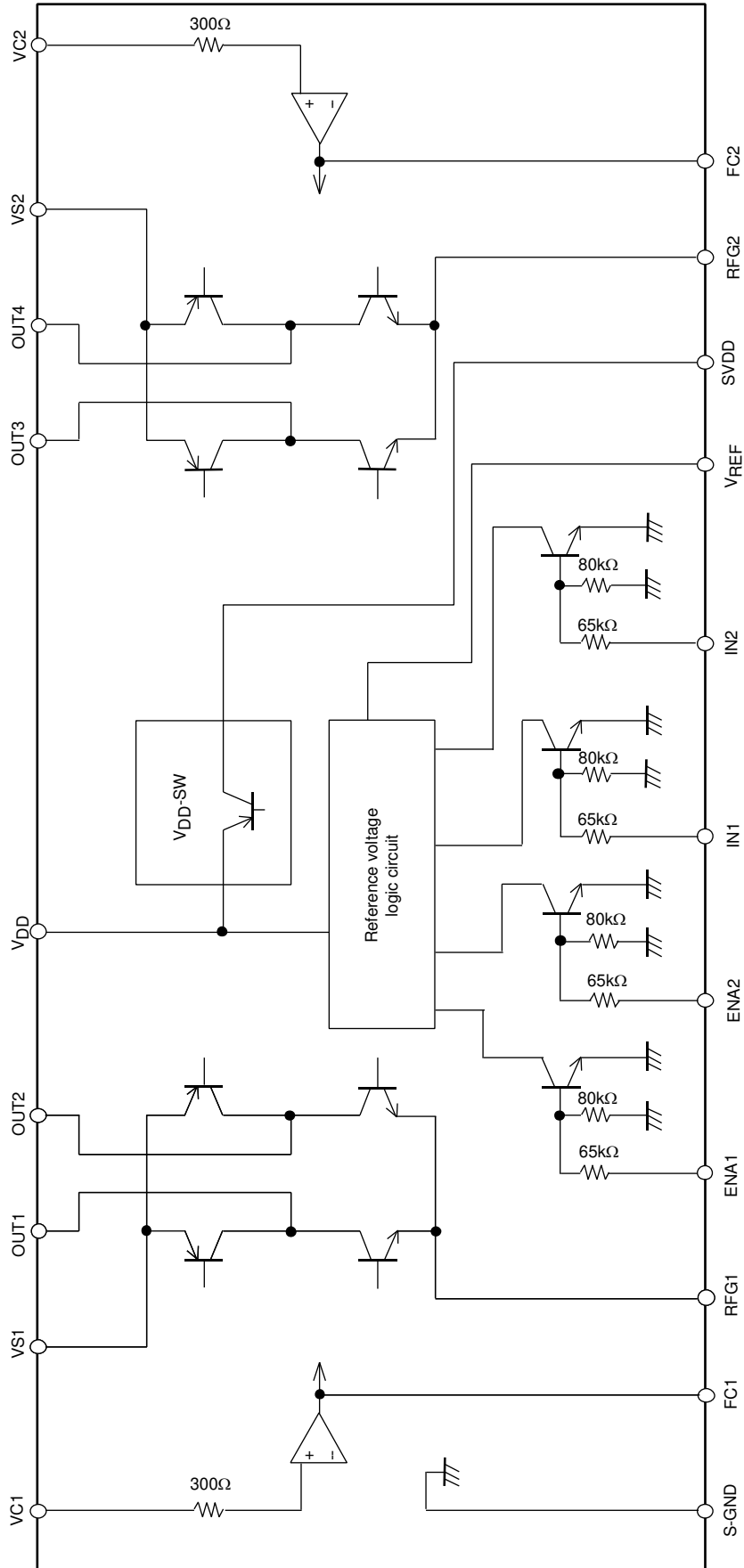
## Application Circuit Diagram
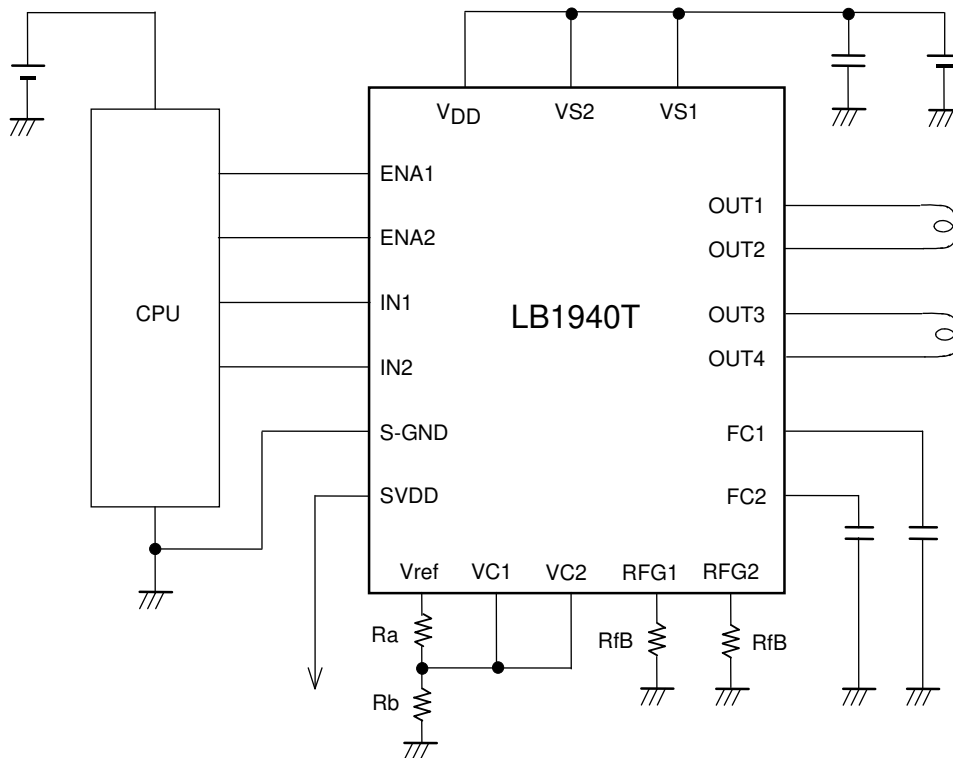


At constant-current control: The OUT current is controlled so that the RFG pin voltage is equal to the VC input pin voltage. For example, $I_{OUT}$ = 200mA (= 0.2V/1Ω) when VC = 0.2V and RFB = 1Ω.

*: There is no priority relationship between respective input voltages (ENA, IN) and respective supply voltages ($V_{DD}$, VS). For example, operation with $V_{IN}$ = 5V, $V_{DD}$ = 3V, VS = 2V is possible.

Note: The input voltage range to the reference voltage input pin VC for constant-current setting is from 0.19V to 1.0V.

## Constant current setting

The composition of the constant-control circuit of this IC is as shown in the figure below.

The voltage entered in the VC pin is entered as a reference to the "+" side input of the constant-current control amplifier.
The "-" side of this constant-current control amplifier is connected to the RFG pin via the wire bonded resistor Rb (= 0.1Ω).
The constant-current control circuit consists of comparison of the voltage generated at the external current detection resistor with the above reference voltage.
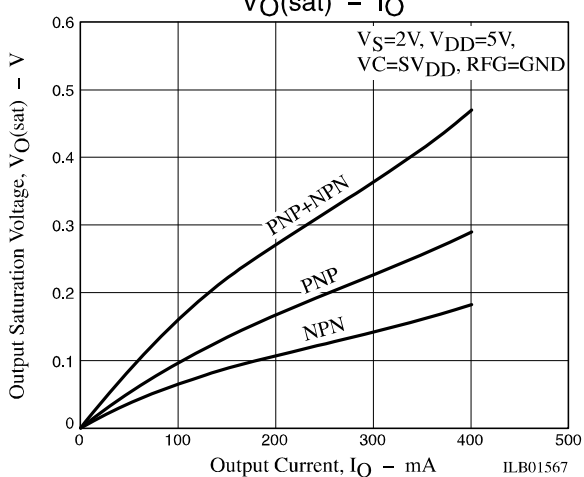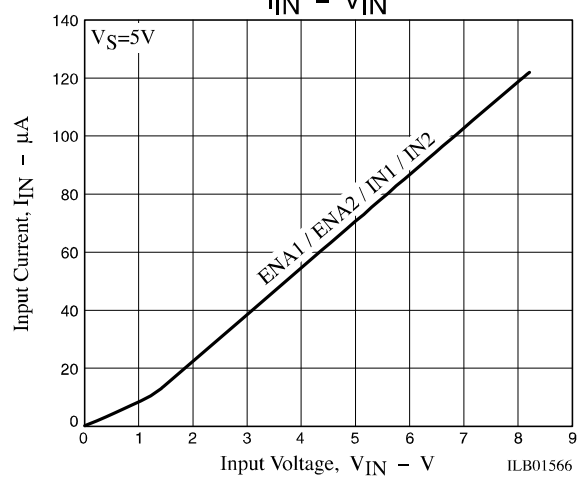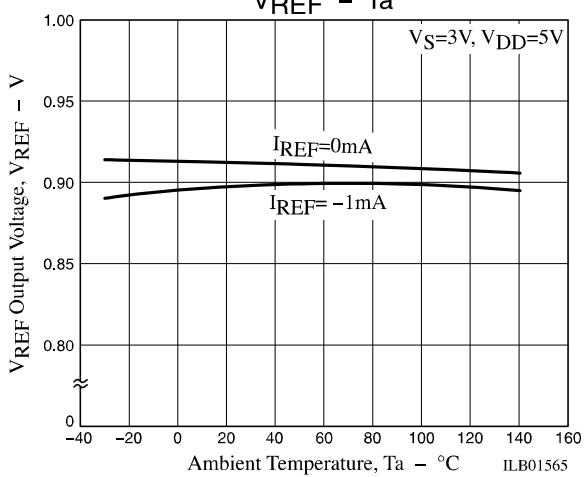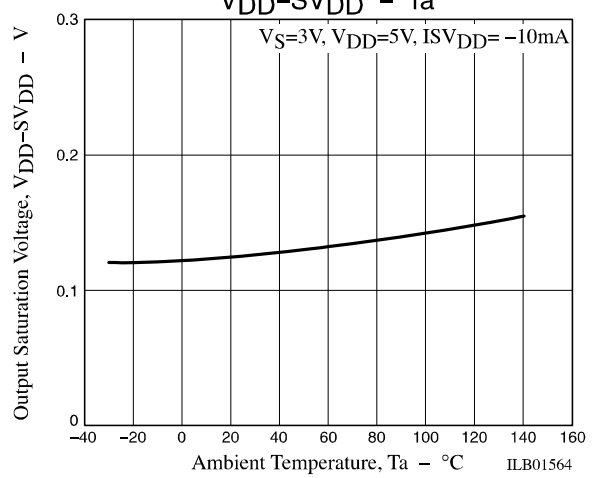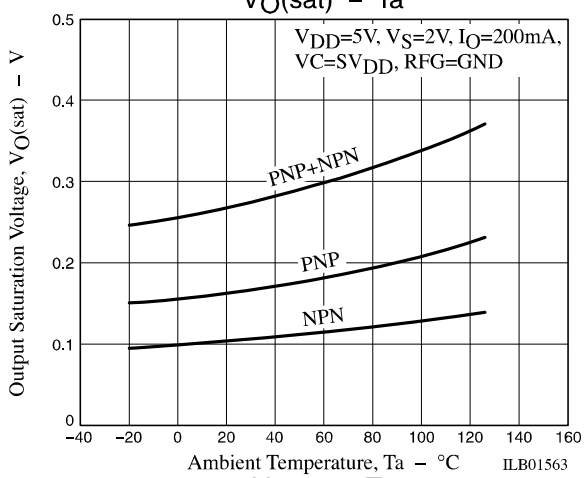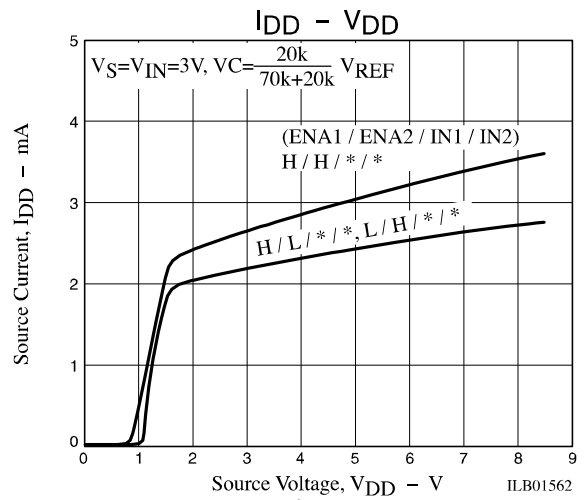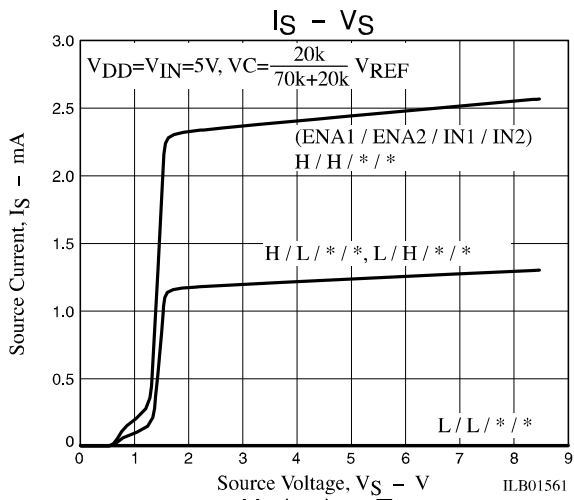


In addition, since the bias current Ib (= 1.5μA) flows out of the positive (+) input of the constant current control amplifier during the constant current control, if the voltage is input to the VC pin by dividing the VREF voltage by 4.5 according to the dividing resistance (70kΩ and 20kΩ) as shown in the figure, the formula for calculating the VC voltage is as follows :

VC = VREF/4.5+Ib×20kΩ = VREF/4.5+0.03

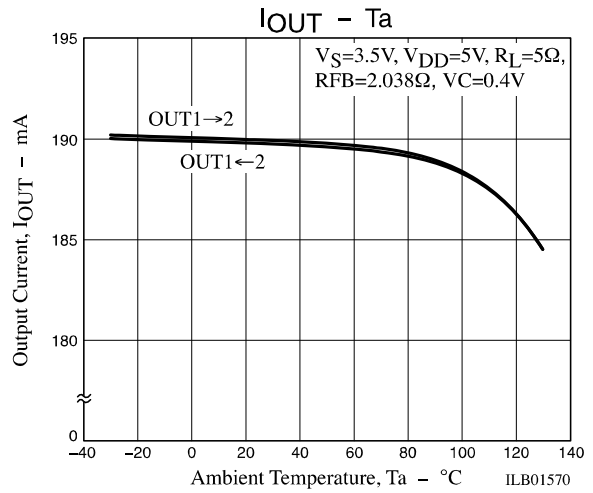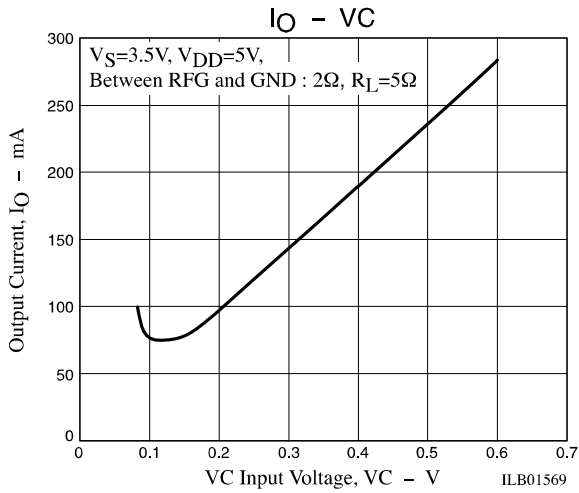Therefore, the theoretical equation to set the constant current $I_{OUT}$ is as follows:

$I_{OUT}$ = VC/(RFB+Rb) = (VREF/4.5+0.03)/(RFB+Rb)

# LB1940T

## $I_S - V_S$

$V_{DD}=V_{IN}=5V$, $VC=\dfrac{20k}{70k+20k}V_{REF}$

(ENA1 / ENA2 / IN1 / IN2)
H / H / * / *

H / L / * / *, L / H / * / *

L / L / * / *

Source Voltage, $V_S$ – V        ILB01561

Source Current, $I_S$ – mA

## $I_{DD} - V_{DD}$

$V_S=V_{IN}=3V$, $VC=\dfrac{20k}{70k+20k}V_{REF}$

(ENA1 / ENA2 / IN1 / IN2)
H / H / * / *

H / L / * / *, L / H / * / *

Source Voltage, $V_{DD}$ – V        ILB01562

Source Current, $I_{DD}$ – mA

## $V_O(sat) - Ta$

$V_{DD}=5V$, $V_S=2V$, $I_O=200mA$,
$VC=SV_{DD}$, RFG=GND

PNP+NPN

PNP

NPN

Ambient Temperature, Ta – °C        ILB01563

Output Saturation Voltage, $V_O(sat)$ – V

## $V_{DD}-SV_{DD} - Ta$

$V_S=3V$, $V_{DD}=5V$, $ISV_{DD}=-10mA$

Ambient Temperature, Ta – °C        ILB01564

Output Saturation Voltage, $V_{DD}-SV_{DD}$ – V

## $V_{REF} - Ta$

$V_S=3V$, $V_{DD}=5V$

$I_{REF}=0mA$

$I_{REF}=-1mA$

Ambient Temperature, Ta – °C        ILB01565

$V_{REF}$ Output Voltage, $V_{REF}$ – V

## $I_{IN} - V_{IN}$

$V_S=5V$

ENA1 / ENA2 / IN1 / IN2

Input Voltage, $V_{IN}$ – V        ILB01566

Input Current, $I_{IN}$ – μA

## $V_O(sat) - I_O$

$V_S=2V$, $V_{DD}=5V$,
$VC=SV_{DD}$, RFG=GND

PNP+NPN

PNP

NPN

Output Current, $I_O$ – mA        ILB01567

Output Saturation Voltage, $V_O(sat)$ – V

## $V_{DD}-SV_{DD} - ISV_{DD}$

$V_S=3V$, $V_{DD}=5V$, ENA1=H

Output Current, $ISV_{DD}$ – mA        ILB01568

Output Saturation Voltage, $V_{DD}-SV_{DD}$ – V

## $I_O - V_C$



$V_S$=3.5V, $V_{DD}$=5V,
Between RFG and GND : 2Ω, $R_L$=5Ω

Output Current, $I_O$ – mA

VC Input Voltage, VC – V

ILB01569

## $I_{OUT} - T_a$



$V_S$=3.5V, $V_{DD}$=5V, $R_L$=5Ω,
RFB=2.038Ω, VC=0.4V

OUT1→2

OUT1←2

Output Current, $I_{OUT}$ – mA

Ambient Temperature, Ta – °C

ILB01570

## ORDERING INFORMATION

| Device | Package | Shipping (Qty / Packing) |
|---|---|---|
| LB1940T-MPB-E | TSSOP20(225mil)<br>(Pb-Free) | 70 / Fan-Fold |
| LB1940T-MPB-H | TSSOP20(225mil)<br>(Pb-Free / Halogen Free) | 70 / Fan-Fold |
| LB1940T-TLM-H | TSSOP20(225mil)<br>(Pb-Free / Halogen Free) | 2000 / Tape and Reel |